How Is This Guide Organized?

There are six investigations in this teacher's guide:

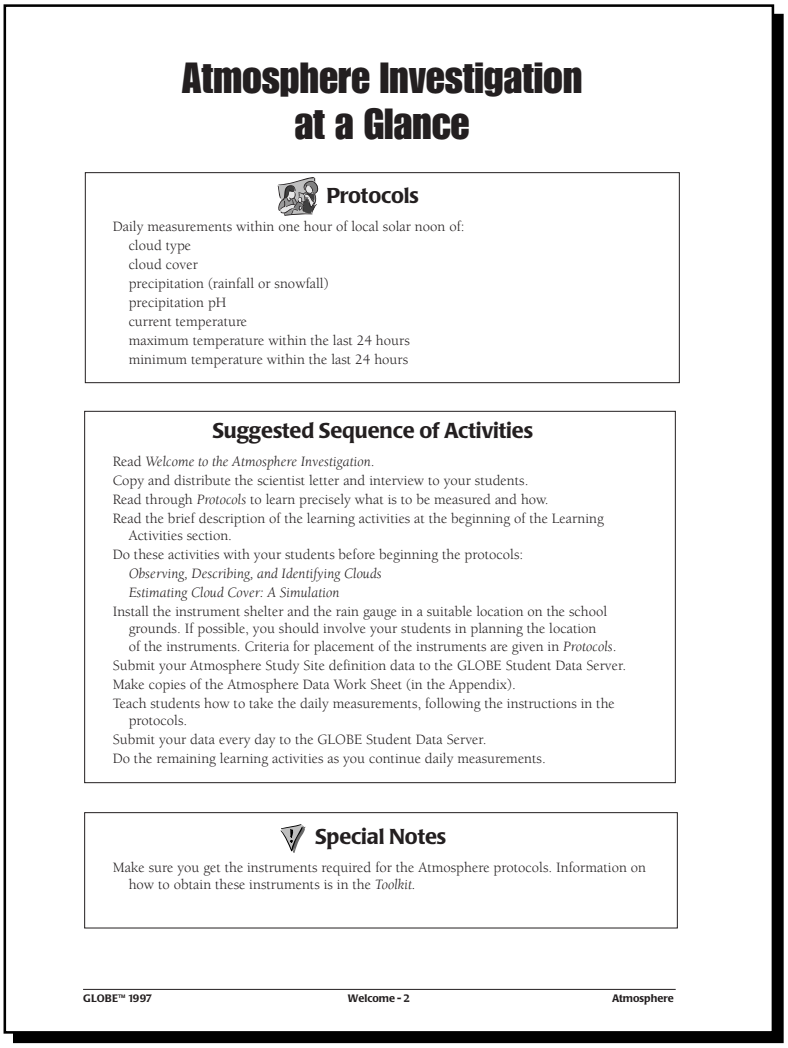
- Atmosphere Investigation
- Hydrology Investigation
- Soil Investigation
- Land Cover/Biology Investigation
- GPS Investigation
- Seasons Investigation

All of the investigations have the same structure, as detailed below. Each provides background information about the subject, instructions on how to do the measurements, and descriptions of a set of learning activities.

As detailed on the next few pages, each investigation has the following sections:

- Welcome to the Investigation
- Introduction
- Protocols
- Learning Activities
- Appendix

Note that the *Seasons Investigation* does not include any additional measurements, and so, it does not have a Protocol section.



Atmosphere Investigation at a Glance

Protocols

Daily measurements within one hour of local solar noon of:

- cloud type
- cloud cover
- precipitation (rainfall or snowfall)
- precipitation pH
- current temperature
- maximum temperature within the last 24 hours
- minimum temperature within the last 24 hours

Suggested Sequence of Activities

Read *Welcome to the Atmosphere Investigation*.
Copy and distribute the scientist letter and interview to your students.
Read through *Protocols* to learn precisely what is to be measured and how.
Read the brief description of the learning activities at the beginning of the Learning Activities section.
Do these activities with your students before beginning the protocols:
Observing, Describing, and Identifying Clouds
Estimating Cloud Cover: A Simulation
Install the instrument shelter and the rain gauge in a suitable location on the school grounds. If possible, you should involve your students in planning the location of the instruments. Criteria for placement of the instruments are given in *Protocols*.
Submit your Atmosphere Study Site definition data to the GLOBE Student Data Server.
Make copies of the Atmosphere Data Work Sheet (in the Appendix).
Teach students how to take the daily measurements, following the instructions in the protocols.
Submit your data every day to the GLOBE Student Data Server.
Do the remaining learning activities as you continue daily measurements.

Special Notes

Make sure you get the instruments required for the Atmosphere protocols. Information on how to obtain these instruments is in the *Toolkit*.

GLOBE™ 1997 Welcome - 2 Atmosphere

Investigation at a Glance

Each investigation begins with Investigation at a Glance. This is a quick overview of the investigation. It summarizes the measurements your students will do. It also recommends a sequence in which you could interweave the learning activities and the protocols. There are many differences among schools and their approaches to GLOBE, and there are many differences among the needs and abilities of individual students. Some schools will just implement the protocols. Others may find that students need more background in the science domain in order to do the protocol.

The general sequence within each investigation is:

1. Students learn about the scientists and their domain of science
2. Students learn how to do the protocol, do pre-protocol learning activities, practice measurement techniques;
3. Students begin making measurements;
4. Students learn more about the domain by studying their local data and data from other schools around the world and doing post-protocol learning activities.

Duplicate and distribute to students.

Scientists' Letter to Students

Dear GLOBE Students,

We are the principal scientists on the GLOBE Hydrology and Water Chemistry investigation, and we welcome you to the program. You are participating in a scientific program that addresses a critical gap in our knowledge about the Earth.

Hydrology is the study of water, one of the most critical resources on Earth. Water is essential to all life. You and your fellow students in schools around the world will collect what should be the broadest set of measurements on water quality compiled to date. This GLOBE program will result in more bodies of water being sampled at the same time than ever before. We hope you find this planetary connection exciting, challenging and important.

In measuring the quality of water on your study site, you will learn much about an important part of your local environment and how it changes throughout the year.

We are very interested in your data and are excited about using the data to answer questions about planetary and local hydrology. So please let us hear from you. As the year progresses, you will hear from us with suggestions about how to interpret your data. We hope that together we can find answers to important water-quality questions.

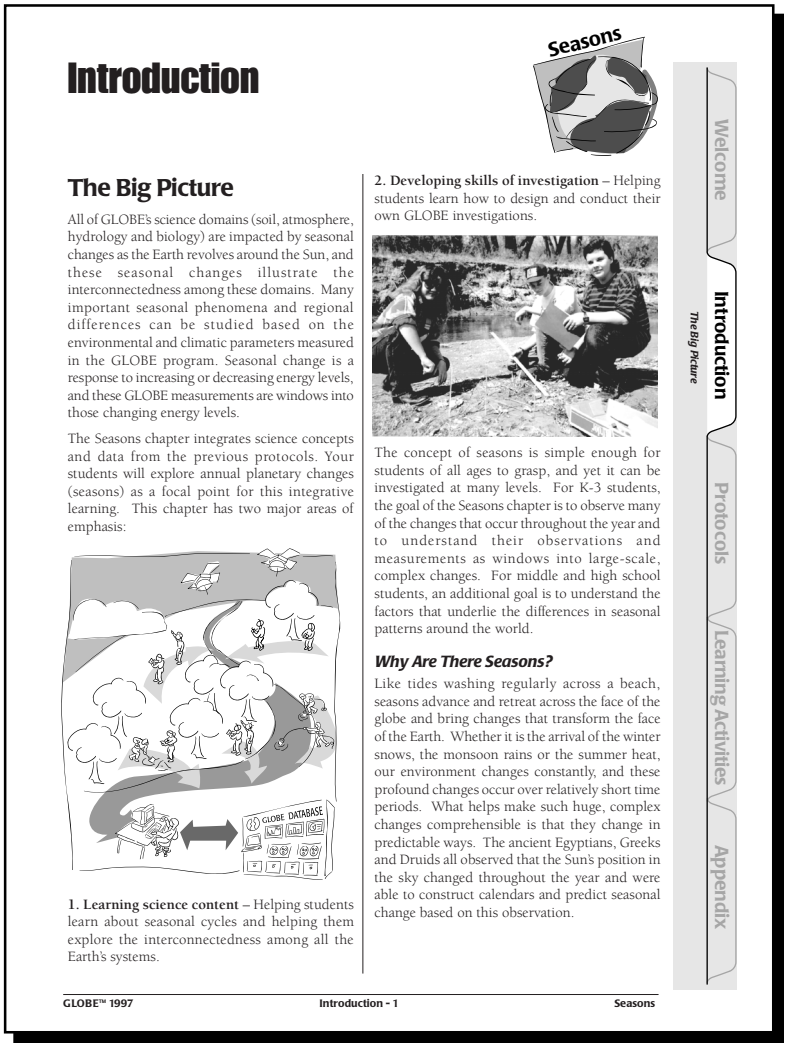
Very truly yours,

Drs. Roger C. Bales & Martha H. Conklin
Professor & Associate Professor
University of Arizona
Tucson, Arizona, U.S.A

GLOBE™ 1997 Welcome - 4 Hydrology

Welcome to the Investigation

The Welcome section helps you and your students get to know the scientists who are responsible for this investigation. It includes a letter from and an interview with the scientists who serve as principal investigators for the investigation. You should copy and distribute or in some way make the scientists' letter and the scientists' interview available to your students.

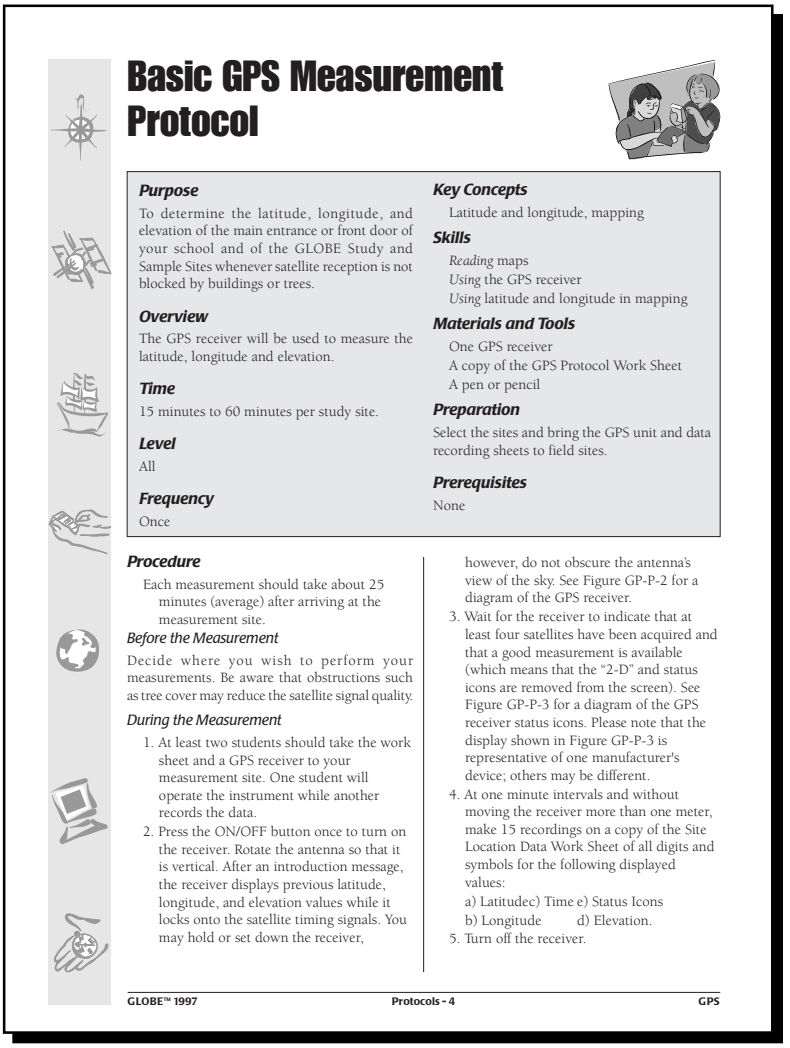


Introduction

The Introduction section sets the stage for the investigation. It provides important background information and helps you and your students appreciate the science of the investigation. It includes:

- an introduction to the *big picture* that puts this investigation in perspective;
- advice on how to prepare for the field work;
- a description of the student learning goals; and
- ideas on how you can assess student learning.

These sections give you, the teacher, background information on the investigation to help you guide the students in their work on GLOBE.



Basic GPS Measurement Protocol

Purpose

To determine the latitude, longitude, and elevation of the main entrance or front door of your school and of the GLOBE Study and Sample Sites whenever satellite reception is not blocked by buildings or trees.

Overview

The GPS receiver will be used to measure the latitude, longitude and elevation.

Time

15 minutes to 60 minutes per study site.

Level

All

Frequency

Once

Key Concepts

Latitude and longitude, mapping

Skills

Reading maps
Using the GPS receiver
Using latitude and longitude in mapping

Materials and Tools

One GPS receiver
A copy of the GPS Protocol Work Sheet
A pen or pencil

Preparation

Select the sites and bring the GPS unit and data recording sheets to field sites.

Prerequisites

None

Procedure

Each measurement should take about 25 minutes (average) after arriving at the measurement site.

Before the Measurement

Decide where you wish to perform your measurements. Be aware that obstructions such as tree cover may reduce the satellite signal quality.

During the Measurement

1. At least two students should take the work sheet and a GPS receiver to your measurement site. One student will operate the instrument while another records the data.
2. Press the ON/OFF button once to turn on the receiver. Rotate the antenna so that it is vertical. After an introduction message, the receiver displays previous latitude, longitude, and elevation values while it locks onto the satellite timing signals. You may hold or set down the receiver, however, do not obscure the antenna's view of the sky. See Figure GP-P-2 for a diagram of the GPS receiver.
3. Wait for the receiver to indicate that at least four satellites have been acquired and that a good measurement is available (which means that the "2-D" and status icons are removed from the screen). See Figure GP-P-3 for a diagram of the GPS receiver status icons. Please note that the display shown in Figure GP-P-3 is representative of one manufacturer's device; others may be different.
4. At one minute intervals and without moving the receiver more than one meter, make 15 recordings on a copy of the Site Location Data Work Sheet of all digits and symbols for the following displayed values:
   a) Latitude c) Time e) Status Icons
   b) Longitude d) Elevation.
5. Turn off the receiver.

GLOBE™ 1997 Protocols - 4 GPS

Protocols

This section describes, in detail, how to conduct the measurements required for the investigation. This includes:

- how to select the study site for the investigation;
- the instruments you need for the investigation;
- how to conduct the measurements; and
- how to submit the data to the GLOBE Student Data Server.

The precise instructions on how to conduct the measurements are called protocols. You will need to read these protocols very carefully before you take the measurements. Later in this chapter, we offer some advice on *How to Teach a Protocol*. Detailed specifications of the instruments you will need to do the protocols are provided in the *Toolkit*.

Leaf Classification

Purpose

Students will learn to classify (sort) a group of objects into different groups (classes). Students will learn about hierarchical classification systems. These fundamental concepts will help students better understand the MUC scheme used in the GLOBE *Land Cover* and *Accuracy Assessment Protocols.*

Overview

Students will gather an assortment of leaves from the school. As a group, they will develop their own classification system for sorting leaves, and will learn that there are different ways to classify the same group of objects. This activity introduces the complexity of a "simple" task for which there are no truly correct answers.

Time

One class period

Level

All

Key Concepts

- Classification helps us organize and understand the natural world.
- A classification system is a set of labels and rules used to sort objects.
- A hierarchical system has multiple levels of increasing detail.

Skills

- *Creating* a classification scheme
- *Using* the scheme to organize objects
- Beginning: *Sorting* and *grouping* objects
- Intermediate: *Using* labels and rules in *classifying* objects
- Advanced: *Using* detailed labels and rules in *classifying* objects

Materials and Tools

- A variety of different leaves
- Chalk board or large paper for classification scheme outline

Preparation

Collect a variety of different leaves.

Prerequisites

None

Background

Scientists classify many features of our environment such as clouds, soil types, or forest types. These classifications help us organize and understand the natural world. A *classification system* is an organized scheme for grouping objects into similar categories. There are two components to a classification system: *labels and rules*. The labels are the titles of the different classes in the classification system; the rules are the tests you apply to decide in which class to place an object. Well-defined labels and rules allow scientists to consistently describe and organize objects. For example, the Modified UNESCO Classification System used in the GLOBE protocols allows GLOBE participants to consistently describe the land cover at any point on earth using the same labels and rules as all the other GLOBE participants.

There are several key characteristics of all good classification systems. First, the classes must be *mutually exclusive* - that is, any object must have only one appropriate class in which it can be placed. If a classification system could place a leaf in either of two categories, then the classes are not mutually exclusive. Second, the classification system must be *totally exhaustive* - that is, there must be an appropriate class for all potential objects. This is frequently achieved by having a catch-all class such as "other". If you have a leaf

Learning Activities

In the Learning Activities section of each investigation a set of activities is provided that you can use to help students learn more about the instruments and protocols, understand the data they collect, and use the GLOBE data to further understand the investigation's key ideas.

At the beginning of each Learning Activity is a box with essential information, in a standard form to help you quickly determine whether this activity is appropriate for your students, based on their ages, interests, and ability levels. In the box at the beginning of the learning activities, Time usually refers to the number of 50 - minute class periods recommended for this activity. Level refers to recommended age levels in three categories: beginning (ages 5-9 years), intermediate (ages 10-13 years), and advanced (ages 14-18 years).

Soil Investigation

Soil pH Data Work Sheet

Date of Sample Collection: __________ Site: __________________________

pH Measurement method (check one): _____paper ______pen _____meter

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Horizon Number:________ Horizon Depth: Top _____ cm

Bottom _____ cm

Sample Number 1

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

Sample Number 2

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

Sample Number 3

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

Horizon Number:________ Horizon Depth: Top _____ cm

Bottom _____ cm

Sample Number 1

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

Sample Number 2

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

Sample Number 3

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

Horizon Number:________ Horizon Depth: Top _____ cm

Bottom _____ cm

Sample Number 1

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

Sample Number 2

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

Sample Number 3

A. pH of water before adding soil: _____

B. pH of soil and water mixture: _____

GLOBE™ 1997 Appendix - 6 Soil

Appendix

The Appendix to each investigation includes Data Work Sheets that can be copied and used by students when they collect their data. Using these sheets reinforces the protocols and helps students remember to record all needed observations. Some of the Appendices contain extensive tables or write-ups that students should take with them when doing the protocols. Also, copies of the Data Entry Sheets from the GLOBE Student Data Server are provided. These sheets are the World Wide Web pages students use to enter their GLOBE data. If your school does not have access to the Web and you are using email or some other means to report your data, these pages will help you and your students better understand the data entries expected by GLOBE. A glossary is provided of the special terms used in connection with the investigation. Also, other material supportive of the investigation is included in the Appendix. Additional items relating to one or more investigations are found in the *Toolkit*.